

A TAXONOMIC REVIEW OF THE GENUS *BRYUM*, MUSCI IN ANTARCTICA

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Abstract: Members of the genus *Bryum* in Antarctica are revised. Only two, *Bryum argenteum* HEDW. and *B. pseudotriquetrum* (HEDW.) GAERTN., MEYER et SCHERB. are so far recognized there as terrestrial species. Another hydrophytic one, *Bryum* sp. occurs at coastal sites of the continent near the Syowa Station. Several bryaceous species hitherto described on the basis of Antarctic material, such as *B. inconnexum* CARD., *B. crateris* DIX., *B. perangustidens* CARD. and *B. ongulense* HOR. et ANDO are suggested to be synonymous with *B. pseudotriquetrum*, in addition to *B. gerlachei* (CARD.) BROTH. and *B. austro-polare* CARD. which have been reduced to synonyms of it before.

1. Introduction

“Antarctica” is used in a narrow sense in the present article for the sake of convenience: the total areas of the Antarctic Continent and adjoining islands situated south of the latitude, *ca.* 62°S. According to the literature, the species of the genus *Bryum* (Bryaceae, Musci) hitherto described on the basis of material collected from there are as in Table 1.

I have not yet been to Antarctica personally, so I had no chances of observing actually the land and plants growing there. Fortunately, however, I could study such several species as also included in Table 1 with the type specimens, the specimens studied by HORIKAWA and ANDO (1961, 1967), and a total of about 120 packets of material collected there by Drs. M. AKIYAMA, S. NAKANISHI and Mr. H. SHIMIZU, who have been the members of the Japanese Antarctic Research Expedition in 1973, 1975–76, respectively, and who actually collected mosses from the Ongul Islands and coastal sites of the continent near the Syowa Station, such as Akarui Point, Langhovde, Skarvsnes, etc. And also I could observe several times the landscapes and the growing habit of mosses there through pictures taken by these members when they had stayed there. On the basis of such observations, I try to present now a preliminary review of the taxonomy of the genus *Bryum* there, though no type specimens have yet been located personally as to a few other species, cited in Table 1 also.

Table 1. Members of the genus *Bryum* hitherto described from Antarctica, the type localities, and later changes in nomenclature after published. An asterisk indicates that the type material has not yet been located personally.

Species	Type locality	Changes in nomenclature
<i>B. algens</i> CARD. (1907)	Terre Victoria, ca. 162°E, 77°S	<i>B. antarcticum</i> (DIXON and WATTS, 1918)
<i>B. austro-polare</i> CARD. (1900)	Canal de Gerlache, ca. 57°W, 64°S	<i>B. antarcticum</i> (DIXON and WATTS, 1918), <i>B. inconnexum</i> (HORIKAWA and ANDO, 1961), <i>B. pseudotriquetrum</i> (OCHI, 1970)
<i>B. cephalozoides</i> CARD. (1906)	Graham: île Paulet, ca. 60°W, 63°S	
<i>B. crateris</i> DIX. (1920)	Deception I., ca. 61°30'W, 63°S	
* <i>B. filicaule</i> BROTH. in DRYG. (1906)	Gaussberg	<i>B. antarcticum</i> (DIXON and WATTS, 1918)
<i>Webera gerlachei</i> CARD. (1900)	Canal de Gerlache	<i>B. gerlachei</i> (BROTHERUS, 1904), <i>B. antarcticum</i> (DIXON and WATTS, 1918), <i>B. pseudotriquetrum</i> (OCHI, 1970)
* <i>B. imperfectum</i> CARD. (1900)	Canal de Gerlache	
<i>B. inconnexum</i> CARD. (1900)	Canal de Gerlache	<i>B. antarcticum</i> (DIXON and WATTS, 1918)
var. <i>tomentosum</i> CARD. (1906)	Wandel I., Canal de Gerlache	<i>B. inconnexum</i> (HORIKAWA and ANDO, 1961)
var. <i>fragile</i> HOR. et Ando (1961)	Japanese Syowa Station, ca. 39°30'E, 69°S	<i>B. inconnexum</i> (HORIKAWA and ANDO, 1967)
<i>B. ongulense</i> HOR. et Ando (1961)	Japanese Syowa Station	<i>B. inconnexum</i> (HORIKAWA and ANDO, 1967), <i>B. algens</i> (SAVICZ-LJUBITZKAJA and SMIRNOVA, 1972)
<i>B. perangustidens</i> CARD. (1911)	Graham: île Genny, ca. 60°W, 63°S	
<i>Webera racovitzae</i> var. <i>laxiretis</i> CARD. (1906)	Wiencke I., Canal de Gerlache	<i>B. inconnexum</i> (HORIKAWA and ANDO, 1961)
<i>B. amblyolepis</i> CARD. (1900)	Canal de Gerlache	
* <i>B. siplei</i> BARTR. (1938)	King Edward VII Land, ca. 155°W, 77°S	
* <i>B. korotkeviciae</i> SAV. et SMIRN. (1959)	Lacus Figurnoje, ca. 101°E, 67°S	
*var. <i>hollerbachii</i> SAV. et SMIRN. (1960)	Near Bangeri Hills, ca. 101°E, 67°S	
* <i>B. antarcticum</i> HOOK. f. et WILS. (1847)	Cockburn I., ca. 57°W, 64°S	

2. Results and Discussion

As already known very well, the genus *Bryum* is quite world-wide, and a lot of species occur in every continent throughout at lower to higher latitudes and altitudes. In studying the floristic affinity or difference of Antarctica, the Antarctic species should be studied in a usual and indispensable way, in comparison with

such species of mosses as in the following groups:

1) Cosmopolitan and widespread species already known to occur at higher latitudes in the Southern Hemisphere: *Bryum argenteum* HEDW., *B. caespiticium* HEDW., *B. capillare* HEDW. and *B. pseudotriquetrum* (HEDW.) GAERTN., MEYER et SCHERB.

2) Antipodals (OCHI, 1973): *B. algovicum* SENDTN. (= *B. pendulum* (HORNSCH.) SCHIMP. *hom. illeg.*), *B. stenotrichum* C. MUELL. (= *B. inclinatum* (BRID.) BLAND. *hom. illeg.*), *B. pallescens* SCHLEICH., *B. turbinatum* (HEDW.) TURN. and *B. uliginosum* B. S. G.

3) Subantarctics (OCHI, 1973): *B. clavatum* SCHIMP. (= *B. erythrocarpoides* C. MUELL. et HAMP.), *B. mucronatum* MITT., *B. laevigatum* HOOK. f. et WILS., *B. kerguelense* MITT. and *B. eatonii* MITT.

Of the species cited above, it is relatively easy to distinguish between the following species: *Bryum argenteum*, *B. capillare*, *B. clavatum*, *B. laevigatum*, *B. mucronatum*, *B. pallescens*, *B. turbinatum*, *B. uliginosum*, *B. kerguelense* and *B. eatonii*, when the well-developed stems with sexual organs are available, because each of these species provides distinct characteristics in sexuality, foliation, leaf-shape, areolation of the lamina, habit of the leaf-margins and costae, etc.; and also the same is between each of them and the rest: *B. algovicum*, *B. stenotrichum*, *B. caespiticium* and *B. pseudotriquetrum*.

2.1. Neither species of the subgenus *Anomobryum* nor *Rhodobryum* (OCHI, 1972) have yet been collected from Antarctica.

2.2. I have actually recognized myself the occurrence there of *Bryum argenteum* HEDW., as other authors had (CARDOT, 1911; HORIKAWA and ANDO, 1961, 1967).

Bryum argenteum HEDW., Spec. Musc., 181, 1801.

Bryum amblyolepis CARD., Rev. Bryol., 27, 45, 1900, *syn. nov.* Type: Canal de Gerlache: XI^{ème} dibarguement sur les cormichers de la falaise, voyage de la Belgica; RACOVITZA, 1 febr. 1898, No. 229b (PC, holotype).

Judging from the description, *B. siplei* BARTR. is possibly conspecific with *B. argenteum* HEDW.

2.3. Another/other larger, terrestrial species of the genus *Bryum* occurring there could be of great taxonomic problem. It has been revealed that this/these species do not belong to any of the former ten species cited above, and that it should be studied in comparison with the latter four species, also cited above: *B. algovicum*, *B. stenotrichum*, *B. caespiticium* and *B. pseudotriquetrum*.

It may be of importance, in determining the species with Antarctic material, to note the following: 1) plants are sterile in almost every case; 2) stems are often undeveloped to bear no sexual organs; 3) plants are very much variable in stature; so are stems in length, thickness, foliation, branching, etc.; and also the leaves vary

in size, shape, serrulation and revolution of the margin, length and thickness of the costa, differentiation of the border, etc.; 4) leaves are often \pm damaged mechanically. From such observations, I have reached a decision to have my own policy of specific determination, on the basis of herbarium specimens without detailed data, only when well-developed stems with sexual organs are obtained in the tuft (cushion). Unless such well-developed stems were available, it would be better for us not to make a definite identification of the species, but merely to name it *Bryum* sp.

Table 2. Diagnostic characteristics of the four species in gametophytes. A little modified from ANDREWS (1940).

<i>Bryum algovicum</i> SENDTN.	Synoiuous. Leaves ovate-lanceolate with a long-acuminate apex, margin strongly revolute, nearly entire; costa very strong, long-excurrent; laminal cells hexagonal-rhomboidal, ca. $50 \times 20 \mu$, with a not sharply defined border.
<i>Bryum stenotrichum</i> C. MUELL.	Synoiuous. Leaves ovate-lanceolate, with a long-acuminate apex, margin strongly revolute, entire; costa strong, excurrent; laminal cells hexagonal-rhomboidal, up to $65 \times 20 \mu$, with a not sharply defined, broad border.
<i>Bryum caespiticium</i> HEDW.	Dioicous. Leaves ovate-lanceolate with a long-acuminate apex, margin strongly revolute, entire or very slightly serrulate in apex; costa strong, generally long-excurrent; laminal cells elongated and narrow, rhomboidal, $70 \times 10 \mu$, without strongly differentiated border.
<i>Bryum pseudotriquetrum</i> (HEDW.) GAERTN., MEYER et SCHERB.	Synoiuous or dioicous. Leaves ovate-lanceolate with a gradually acuminate apex and \pm decurrent base; margin reflexed throughout, entire; costa strong, percurrent or slightly excurrent; laminal cells hexagonal-rhomboidal, up to $50 \times 15 \mu$, distinctly bordered at margin.

It seems very difficult to distinguish the above four species from each other with sterile material, even when the stems bear sexual organs, since these species have been recognized by some authors (ANDREWS, 1940; SAINSBURY, 1955) as showing few differences between them, from the observations of the gametophytes only, as cited in Table 2. (From the observations of many specimens collected from various localities throughout the world, of the characteristic expressions for *B. pseudotriquetrum* by ANDREWS cited in Table 2, "leaves . . . with a \pm decurrent base" is real, but some others are not always real: "margin reflexed" is not always real, since the difference is not so obvious between "reflexed" and "revolute;" "margin entire" seems to indicate that he did not observe the leaves quite in detail, since a peculiar serrulation is observed on the leaves as stated elsewhere by myself in the text; in spite of the fact that he has circumscribed *B. pseudotriquetrum* as including dioicous and synoiuous forms in a single species, he did not observe the synoiuous form sufficiently as to the excurrency of the costa: the costa is really "percurrent or slightly excurrent" in the dioicous form, whereas often relatively long-excurrent in the synoiuous form.)

We should find out good characteristics with which these four could be dis-

tinguished correctly even with such material. The ultimate problems we are confronted with directly would be 1) distinction of three synoicous forms: *B. algovicum*, *B. stenotrichum* and the synoicous form of *B. pseudotriquetrum*; and 2) between the dioicous two: *B. caespitium* and the dioicous form of *B. pseudotriquetrum*.

Observing the stems of these species in detail, however, it has been revealed by myself that the leaves have a peculiar serrulation in the upper part of the margin, in addition to the \pm decurent base, in *B. pseudotriquetrum*, and that such serrulation is stable not only on the leaves of fruiting plants collected from lower latitudes but also even on sterile, relatively well-developed stems (without sexual organs) collected from higher latitudes including Antarctica (Fig. 1). As indicated in Fig. 1, the serrulae are four or rarely five only in the uppermost part of the margin, where it is often plane, and these become gradually smaller and more spaced toward the

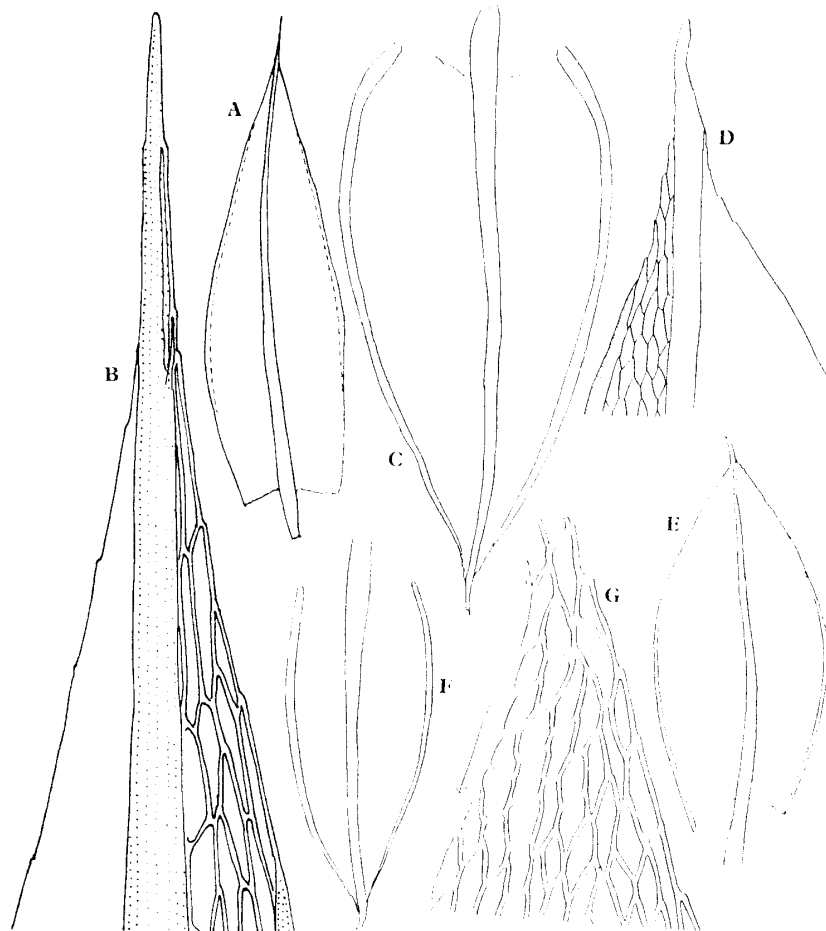


Fig. 1. *Bryum pseudotriquetrum* (HEDW.) GAERTN., MEYER et SCHERB.: A, C, E and F. Leaves, $\times 22$. B and D. Leaf-apices, $\times 200$ and 48 , respectively. G. Apical margin of leaf, $\times 200$. A and B from HORIKAWA and ANDO (1961), and the rest from OCHI (1970).

lower part. This pattern of serrulation appears to be the same either in both synoicous and dioicous forms of this species, though the range of serrulation appears to be larger in length in synoicous than in dioicous form. (This may be natural considering the facts that the lamina is generally more elongate and longer-acuminate in the synoicous form and that the laminal cells are also more elongate in it.) In contrast, in the other species cited in Table 2, the leaf-margins are entire, or serrulate or crenulate indistinctly or far more distantly in the upper part. Observing in detail the plants of these species in this way, we can distinguish them from each other in many cases even with sterile Antarctic material, though such a peculiar serrulation does not always appear on every leaf of such well-developed stems, and though it is often not so obvious or not at all represented on the leaves of less

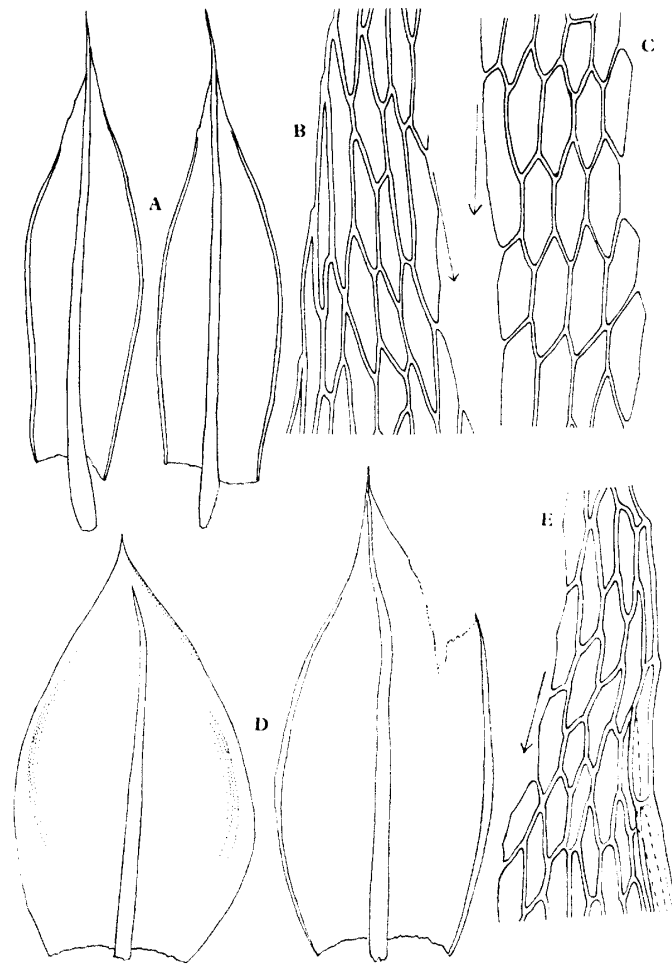


Fig. 2. *Bryum pseudotriquetrum* (HEDW.) GAERTN., MEYER et SCHERB.: A and D. Leaves, $\times 22$. B and E. Apical margins of leaves, $\times 200$. C. Median laminal cells, $\times 200$. A–C drawn from type of *B. crateris* (BM), and the others from "Langhovde: SHIMIZU 751125–300."

developed stems. (It is often impossible for us to distinguish *B. algovicum* from *B. stenotrichum*, unless good capsules have been available for study.)

Finally, it should be so far concluded that such larger Antarctic bryaceous species belongs to a single species, the so-called "bimum"-form of *B. pseudotriquetrum*, and that no other species seems to be recognized there.

B. inconnexum CARD., *B. crateris* DIX., *B. perangustidens* CARD., *Webera gerlachei* CARD. (= *B. gerlachei* (CARD.) BROTH.), *B. austro-polare* CARD. and *B. ongulense* HOR. et ANDO seem to be synonymous with *B. pseudotriquetrum*, as already published (OCHI, 1970) or suggested (OCHI, 1976).

The type material of *B. cephalozoides* (type in PC seen), *B. inconnexum* var. *tomentosum* CARD. (isotype in H seen), *B. inconnexum* var. *fragile* HOR. et ANDO (type in HIRO seen) and *Webera racovitzae* var. *laxiretis* CARD. (isotype in H seen) consists of sterile, less developed stems without sexual organs; the peculiar serrulation at the uppermost part of the lamina is indistinct or absent in these species. As stated above, it may be better not to determine the species definitely on the basis of such incomplete material, but to name it merely *Bryum* sp., although such undeveloped plants may possibly belong also to *B. pseudotriquetrum*, in view of the wide range of the variability in Antarctica (HORIKAWA and ANDO, 1967; SAVICZ-LJUBITZKAJA and SMIRNOVA, 1972) and the growing habit observed in the Syowa Station area.

SAVICZ-LJUBITZKAJA and SMIRNOVA (1972, and also unpublished translation by the Antarctic Survey, Manchester) emphasized the validity of *B. algens* CARD., and also considered that *B. ongulense* is conspecific with *B. algens*. In their paper they stated that "we obtained from the herbarium of the National Museum of France a specimen of *B. algens* determined by CARDOT himself," and also that

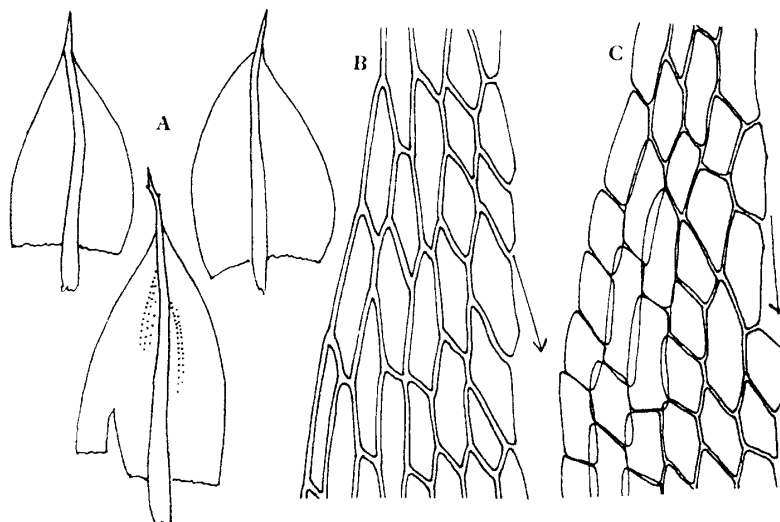


Fig. 3. *Bryum algens* CARD.: A. Leaves, $\times 22$. B. Apical margin of leaf, $\times 200$. C. Median laminal cells, $\times 200$. Drawn from type (PC).

“we also borrowed some stems of *B. algens* . . . from the State Museum in Stockholm.” But they made no mention of “examination of the type specimen. . .,” or gave no definite remark such as “drawn from the type” in the captions of the four figures in their paper. Judging from these expressions in their paper, it is doubtful if they had actually examined the type of *B. algens*. Furthermore, they studied “*B. algens*” mostly with the specimens collected from the “Eastern Antarctica,” and with few specimens from the Western Antarctica or with a few species occurring at higher latitudes in the other regions of the Southern Hemisphere for comparison.

The type material of *B. algens* available from PC for the present study, “Terre Victoria: Granite Harbour, L. S. 77°, Exped. de la Discovery, 20/1 1902” consisted of only several sterile stems without sexual organs (Fig. 3). As seen from Fig. 3, the leaves are relatively small, with a short-acuminate apical part, scarcely decurrent base, plane margins having no serrulation in the uppermost part, the scarcely differentiated border, and a very strong, sometimes very long-excurrent costa. Emphasizing the relatively small lamina, scarcely decurrent base, relatively narrow laminal cells and the long-excurrent costa, this moss may be more closely related to *B. caespitium* than to *B. pseudotriquetrum*. On the other hand, emphasizing the very strong, often short-excurrent costae, this moss may still be a form of *B. pseudotriquetrum*. But it may be wise not to discuss on the taxonomy of *B. algens* further more on the basis of such scanty, incomplete material available, since the range of variability in the species could not be confirmed only with such several stems examined, as SAVICZ-LJUBITZKAJA and SMIRNOVA (1972) did. The same is with *B. filicaule* BROTH. and *B. imperfectum* CARD., since no type material of these species have yet been located, respectively.

In summary, the nomenclature could be treated as follows:

Bryum pseudotriquetrum (HEDW.) GAERTN., MEYER et SCHERB., Oek. Techn. Fl. Wetterau, 3 (2), 102, 1802.

Bryum inconnexum CARD., Rev. Bryol., 27, 44, 1900, *syn. nov.* Type: Canal de Gerlache: XX^{ème} dibarguement, sur les roches au milieu d'un glacier, alt. 50 m, Exped. Antarct. Belge, RACOVITZA, 12/2 1898, No. 268a (H, isotype).

Webera gerlachei CARD., *l.c.*, 44.

Bryum gerlachei (CARD.) BROTH., Nat. Pfl., 1 (3), 580, 1904.

Bryum austro-polare CARD., *l.c.*, 45.

Bryum perangustidens CARD., Rev. Bryol., 38, 127, 1911, *syn. nov.* Type: Terre de Graham: isle Genny, sur la terre humide, jan. 1909, *ex* Herb. Paris 243 (BM, isotype).

Bryum crateris DIX., Bryologist, 23, 67, 1920, *syn. nov.* Type: Deception I., J. C. ROBBINS, 1908, No. 451. (BM, holotype; H, isotype).

Bryum ongulense HOR. et ANDO, Hikobia, 2 (3), 166, f. 4, 1961, *syn. nov.* Type: The Ongul Is., E. Ongul I., 300 m W. of Syowa Station, Feb. 1957, T. KAJI, No. 12 (HIRO, holotype).

2.4. In addition to the two terrestrial bryaceous species discussed above, another hydrophytic bryaceous moss was collected from the bottom of some ponds, which are situated at the coast of the continent near the Syowa Station. This moss was for the first time collected by Dr. M. AKIYAMA (algologist) in 1973, and then by Dr. S. NAKANISHI and Mr. H. SHIMIZU, respectively, in 1975–76. This moss is externally very similar to *Bryum korotkevicziae* SAV. et SMIRN. or its variety *hollerbachii* SAV. et SMIRN., as was annotated by NAKANISHI (1977). It may be better now, however, not to determine the species definitely, but merely name *Bryum* sp. for it, since the plants are sterile, filiform and without sexual organs. It is hoped in the near future that an investigation of this moss will be carried out in comparison to *B. korotkevicziae* or its variety *hollerbachii* with the type material.

2.5. Another terrestrial moss, which appears externally somewhat bryaceous, was collected by Dr. NAKANISHI and Mr. SHIMIZU in 1975–76 from the coastal sites of the continent near the Syowa Station. This moss has been treated by NAKANISHI (1977) under the name of *Bryum antarcticum*. The plants represent the following characteristics:

Dioicous (?). Plants small, densely tufted, hardly lustrous. Stems simple or branched by 2–3 innovations. Leaves usually crowded in the upper part of stem, \pm twisted or wrinkled and appressed to stem when dry, erect-spreading when moist, ovate with a short-acuminate apex and a broad base, *ca.* 1.1×0.5 mm; margins entire, plane or slightly reflexed; costa rather slender, nearly percurrent or short-excurrent. Laminal cells thin-walled, *short-rhomboidal* or *-rectangular*, shorter and tending to be \pm hexagonal in the apical part, more elongate in the basal part; not bordered. Perichaetial leaves more elongate with a longer-acuminate apex. Innovation leaves imbricate, smaller with a less acuminate apex and a shorter, thinner costa. Described on the basis of “Skarvsnes: Suribati Ike, H. SHIMIZU, Jan. 21, 1976, No. 6.”

From the observations cited above, this moss is considered neither to be the species in the genus *Bryum* nor *Pohlia*, but appears to be a species in another family, probably such as Funariaceae or Pottiaceae. In addition, this moss has been studied cytologically by INOUE (1976), and the chromosome number was counted as $n=26+2$. The basic chromosome number in the genus *Bryum* (*sens lato*) or *Pohlia* is $n=10$ or 11 (YANO, 1956) and never 13 . Judging from these facts, this species should clearly be excluded from the genus *Bryum* there.

I have not yet studied *B. antarcticum* with the type material personally. I hesitate now to accept the NAKANISHI's treatment as correct. I hope to study this species with the type material in the future separately.

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making the specimens available for study: British Museum (Nat. Hist.), London (BM); Muséum National d'Histoire Naturelle, Laboratoire de Cryptogamie, Paris (PC); Botanical Museum, University of Helsinki (H); and Department of Botany, Faculty of Science, Hiroshima University (HIRO). My cordial thanks are also due to Drs. M. AKIYAMA, Shimane University; S. NAKANISHI, Kobe University; H. ANDO, Hiroshima University, H. KANDA, National Institute of Polar Research, Tokyo; and Mr. H. SHIMIZU, Tottori University for providing the specimens and literature.

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